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~~ELECTRIC GENERATOR~~

FIELD OF THE INVENTION.

The present invention relates to electric devices including generators which generate an electric current and electric motors.

BACKGROUND ART.

Most electrical devices include a magnetic field and a magnetically permeable structure which are involved in relative movement. During that movement there is normally a symmetrical motion in which magnetic repulsion during one part of the motion is disadvantageous and magnetic retardation during another part of the motion is also disadvantageous.

The object of the present invention is to provide both an electrical device and a method of generating an electric current in which the disadvantageous magnetic retardation is reduced.

SUMMARY OF THE INVENTION.

In accordance with a first aspect of the present invention there is disclosed a method of generating an electric current, said method comprising the steps of:

1. creating a magnetic field extending from a first magnetic pole to a second magnetic pole,
2. creating a first magnetically permeable path extending from adjacent said first magnetic pole to adjacent said second magnetic pole,
3. winding a coil about said first magnetic path,
4. connecting an electrical load across said coil,
5. connecting a switch means in series with said coil,
6. enabling a second magnetically permeable path to move relative to said poles into a position between said first and second magnetic poles to shunt said first magnetic path,
7. moving said second magnetically permeable path relative to said poles out of said position between said first and second magnetic poles, and

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8. opening and closing said switch means so that said switch means is closed when said second magnetic path is moving into said position and opened when said second magnetic path is moving out of said position.

In accordance with a second aspect of the present invention there is disclosed an electrical device comprising a magnetic field means having first and second magnetic poles between which a magnetic field extends, a first magnetically permeable path carrying a coil and extending from adjacent said first magnetic pole to adjacent said second magnetic pole, and switch means connected in series with said coil, a second magnetically permeable path mounted for movement relative to said poles into and out of a position between said first and second magnetic poles in which said second path shunts said first path, and means to close said switch means as said second path moves towards said position and open said switch means as said second path moves out of said position.

BRIEF DESCRIPTION OF THE DRAWING.

Two embodiments of the present invention will now be described with reference to the drawings in which:

Fig 1 is a perspective view of a single coil generator in accordance with a first embodiment of the present invention,

Fig 2 is a schematic magnetic circuit diagram and current waveform illustrating a first half cycle of operation of the apparatus of Fig 1,

Fig 3 is a diagram similar to Fig 2 but illustrating the other half cycle of operation, and

Fig 4 is a plan view of the disc of a multi-coil machine.

DETAILED DESCRIPTION

As seen in Fig 1, a first embodiment of a generator 1 has a base plate 2 on which is mounted a prime mover in the form of an electric motor 3. Clearly any other form of prime mover such as an internal combustion engine, turbine, hydraulic motor, or the like will suffice. The motor 3 has a shaft 4 which is supported by bearings 5,6.

An insulative, non-permeable disc 7 is mounted on the shaft 4 for rotation therewith. Set into the disc 7 is a ferromagnetic bridge 8 and a curved conductive track 9. Mounted on an insulative support 11 are a pair of carbon brushes 12, 13. Mounted to the rear side of the disc 7, and thus indicated by broken lines in Fig 1, is a U-shaped permanent magnet 14 having a north pole N and a south pole S (Fig 2). Opposite the magnet 14 is a U-shaped magnetically permeable core 15 formed from steel laminations or the like and upon which is wound a coil 16.

The coil 16, brushes 12, 13 and an electrical load in the form of resistor R are connected in series. It will be apparent to those skilled in the art that the track 9 and brushes 12, 13 function as a rotary switch which open circuits the the coil 16 or connects the resistor R across it in accordance with the position of the disc 7. The track 9 and brushes 12, 13 are so arranged that the coil 16 is connected to the resistor R whilst the bridge 8 is approaching the core 15 and whilst the bridge 8 and core 15 are aligned. However, as the bridge 8 begins to leave the core 15 with continued rotation of the disc 7, the brushes 12, 13 are open circuited by the departure of the track 9 from underneath the brushes 12, 13.

Turning now to Figs 2 and 3, the magnetic circuit formed by the core 15, magnet 14 and bridge 8 is schematically illustrated. Although the bridge 8 is very thin in the direction perpendicular to the plane of the disc 7, it has an appreciable extent in the plane of the disc 7 and thus a low reluctance. This is indicated in Fig 2 by the bridge 8 being drawn larger than it would appear in cross-section.

When the bridge 8 is absent, as illustrated in Fig 3, the magnetomotive force of the magnet 14 causes a certain level of flux $\Phi 2$ to be present in the core 15. Because of the relatively large air gaps in the absence of the bridge 8, the magnetic circuit as illustrated in Fig 3 has a relatively high reluctance. However, as seen in Fig 2, with the bridge 8 shunting the core 15, a relatively low reluctance path is available from the north pole N to the south pole S of the magnet 14 via the bridge 8 and two relatively small air gaps. Thus essentially most of the magnetic flux from the magnet 14 is present as flux Ø1 in the bridge 8. Almost no flux passes through the core 15.

Largely because of the change in air gap sizes, the reluctance of the magnetic circuit in the configuration illustration in Fig 2 is less than the reluctance of the magnetic circuit in the configuration illustrated in Fig 3. That is, $\Phi 1$ is larger than $\Phi 2$.

As a consequence, the magnetic potential energy of the circuit in the configuration of Fig 2 is less than that of the circuit in the configuration illustrated in Fig 3. This may be illustrated by gently spinning the disc 7 by hand. The disc 7 will come to rest (normally after a few oscillations as the disc 7 slows) with the bridge 8 positioned in line with the magnet 14 and core 15. That is, in the configuration illustrated in Fig 2.

Expressed another way, as the bridge 8 approaches the magnet 14, the lower magnetic energy state of Fig 2 will cause the bridge 8 to be drawn towards the magnet 14. Similarly, as the rotation continues and the bridge 8 moves away from the magnet 14 an effort is required to maintain the rotation as the higher magnetic potential energy state(s) are attained. For each revolution the effort of removing bridge 8 from the magnet 14 is substantially equal to the impetus gained by the disc 7 as the bridge 8 approaches the magnet 14.

As the bridge 8 approaches the magnet 14, defining a first half cycle, a steady flux Ø2 is in the core 15 and links the coil 16. As the bridge 8 progressively shunts the flux in the core 15, the magnetic field in the coil 16 collapses. Thus an electromotive force is generated in the coil 16. Since the coil 16 is connected to the load resistor R via the brushes 12, 13 and the track 9, a current flows in the coil 16 as illustrated in Fig 2.

Conversely, as the bridge 8 moves away from the magnet 14, defining a second half cycle, at first there is a small amount of flux in the core 15, and the flux progressively increases to Ø2. Thus an electromotive force is generated in the coil 16. If the coil 16 were not open circuit, a current indicated by broken lines in Fig 3 would flow (with reverse polarity to the current in Fig 2). However, the brushes 12, 13 and track 9 are open circuit, so no current flows.

Thus, at this time, the disc 7 is only impeded by the attraction of the magnet 14 for the bridge 8. As a result, the impediment to continued rotation of the disc 7 is at a minimum and the efficiency of the generator 1 is increased.

The current flowing in the coil 16 generates an induced magnetic flux in the core 15 which increases the magnetic flux in the core 15. This induced magnetic flux increases with increasing speed of the disc 7. The speed of the disc 7 reaches a critical speed, at which the magnitude of the induced flux is equal to the magnitude of the flux supplied by the magnet 14. Thereafter, increasing speed causes increased induced flux in the core 15 and the device runs as a motor.

It will be appreciated that the current generated by the arrangement in Fig 1 is unidirectional in that current is generated only intermittently. However, with the duplicated arrangement as illustrated in Fig 4, two bridges 8, 108 are provided together with two tracks 9, 109, two pairs of brushes 12, 13 and 112, 113 and two pairs of coils 16, 116 each with its corresponding magnet (14, 114). Thus with the arrangement of the disc 107 of Fig 4, two pulses are generated for each revolution of the disc 107. Depending upon the relative phasing of the coils 16, 116, the current supplied to the resistor R can be either 2 pulses of the same polarity (i.e. unidirectional current) or 2 pulses of opposite polarity (i.e. bi-directional current or AC).

That is, either DC current or single phase alternating current can be generated. By providing 3 discs 107 rotated by 120° to each other on the same shaft 4, three phase alternating current can be generated with the 3 resistors being connected in either Y or delta configuration as is well known to those skilled in the electric generating arts.

The foregoing describes only some embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the present invention. For example, the permanent magnet(s) 14, 114 can be replaced by an electromagnet having a magnetic field generating current. The magnitude

of the current generated or the speed of the motor, can be controlled by controlling the magnetic field of the device. For example, the field current of an electromagnet replacing magnet 14 can be controlled. Other ways of controlling the magnetic field include adjusting the size of air gaps in the magnetic circuit or other arrangements to adjust the reluctance of the magnetic path by, for example, changing the size of the core 15. Alternatively, a small winding can be wound about the magnet 14 to increase or decrease its magnetic field.

Furthermore, control can also be effected by utilizing a control resistor in series with the coil 16 instead of the open circuit as described above. As the resistance of such a control resistor is progressively decreased from an initial very high value, so the current generated, or motor speed, is decreased. Other control methods include electronically clipping the voltage in coil 16 and/or electronically controlling the current in coil 16.

Similarly, rather than use a mechanical switch in the form of tracks 9, 109 and brushes 12, 13, 112, 113, a solid state switch utilizing SCRs, thyristors, transistors, or even diodes can be employed. Such SCRs and thyristors can be triggered by stationary sensing coils in which trigger currents can be generated by small auxiliary magnets carried by the discs 7, 107. Also rather than a closed circuit/open circuit being used as the switch means, a low resistance/high resistance circuit can be used instead.

Finally, although the disc 7, 107 is preferably rotated in one direction as described above, it will be apparent to those skilled in the art that the disc 7, 107 can be oscillated (as indicated by the broken line arrow in Fig. 1) rather than rotated. In one such embodiment, the stationary end point of the oscillation would see the bridge 8 fully inserted between the magnet 14 and core 15.

The term "comprising" (and its grammatical variants thereof) is used in the inclusive sense of "having" or "including" and not in the exclusive sense of "consisting only of".